Reflecting on 25 years of bioassessment research: How serendipity led to a personal and professional obsession

Chuck Hawkins

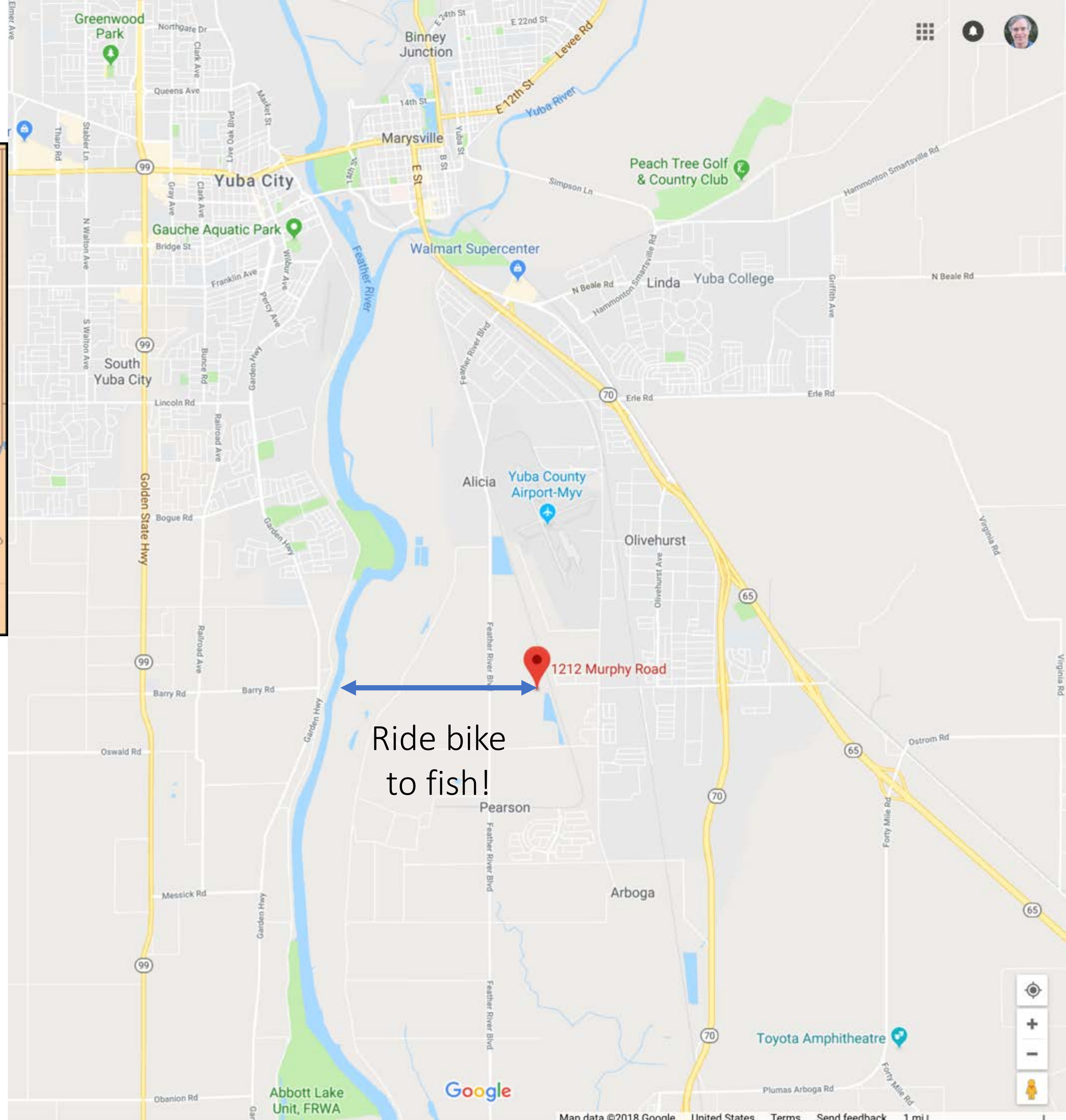
Utah State University

WATERSHED
SCIENCES
ECOLOGY CENTER

ARBOGA

Laura and Michael from Arboga, Sweden
visit Arboga, California.
They were a little creeped out!

https://youtu.be/UWcN2RN7EIY



Such close proximity to the river had other consequences, though!

1955 Yuba River flood:
4-year old Chuck spends Christmas in a Boy Scout lodge in the foothills.

This one finally got my mother's house.

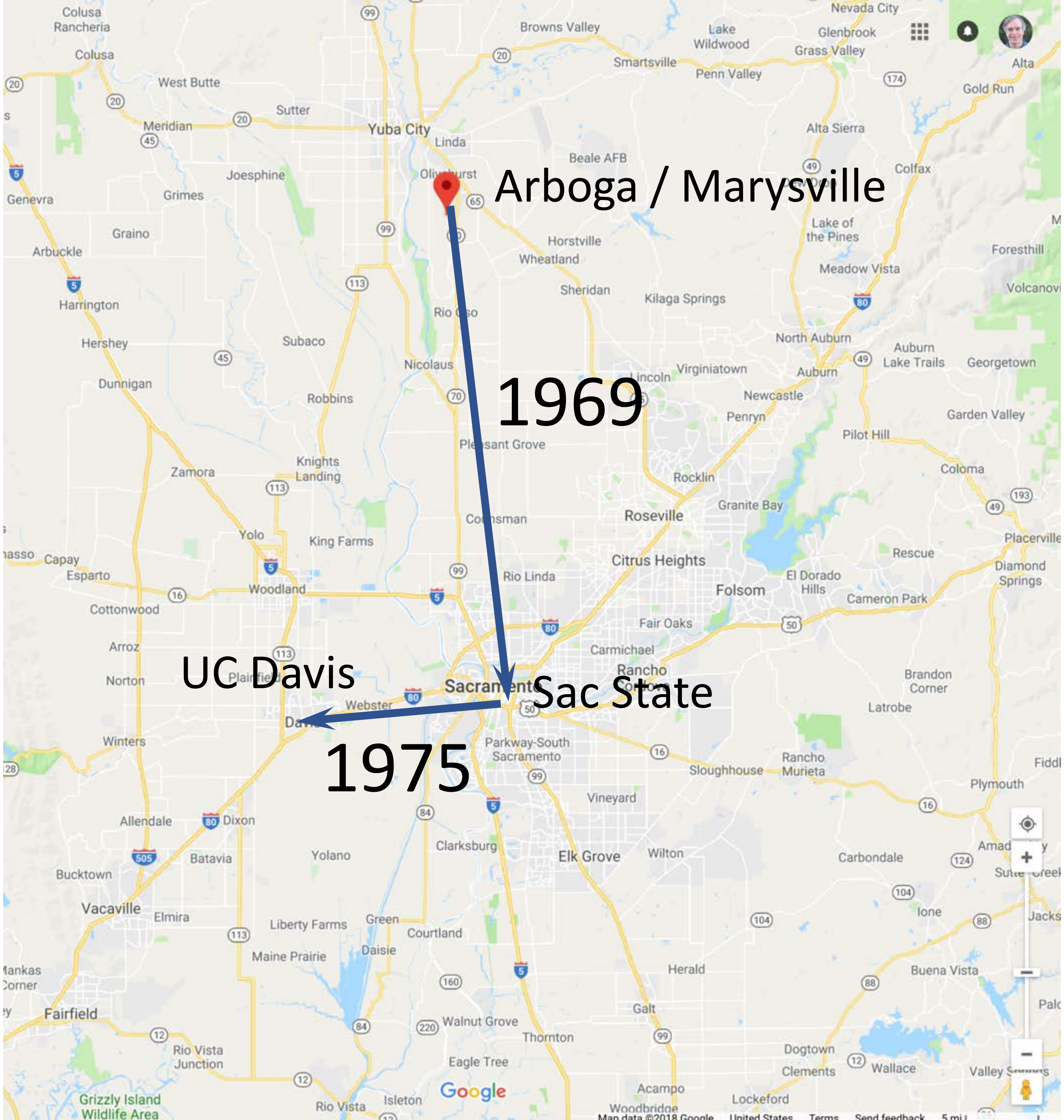
1986 flood


San Francisco Examiner

Yuba levee breaks, 20,000 flee floods

Water stuns Linda, but all reach shelte

A 'break' in slaying of Marcos foe


Arboga / Marysville
1969
Sac State
UC Davis
1975

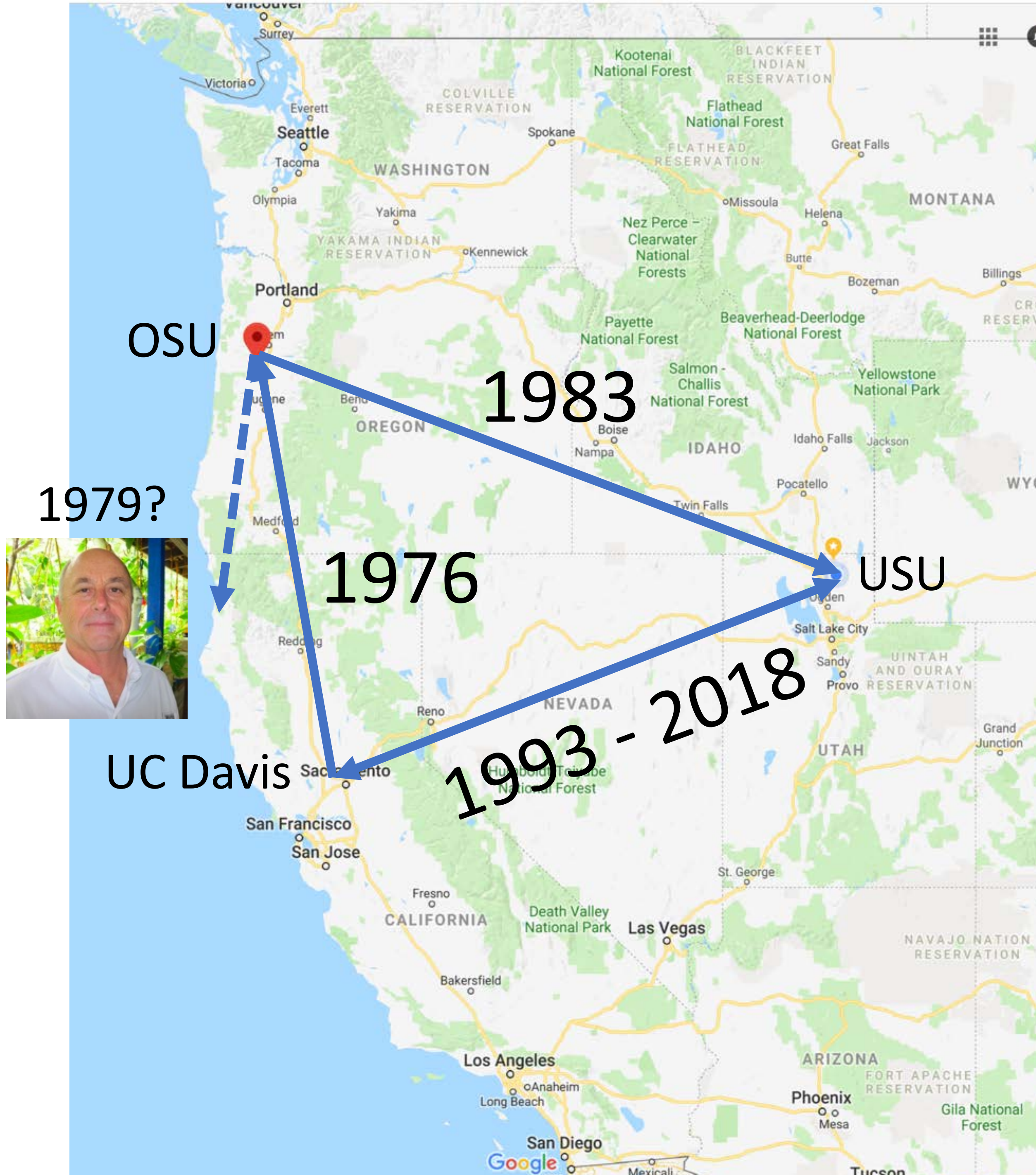
1976
River Continuum technician

1978 - 1982
PhD at OSU on comparative ecology of ephemerellid mayflies

Side project on effects of sediment and riparian cover on stream communities – met Jim!

1983
Faculty at USU

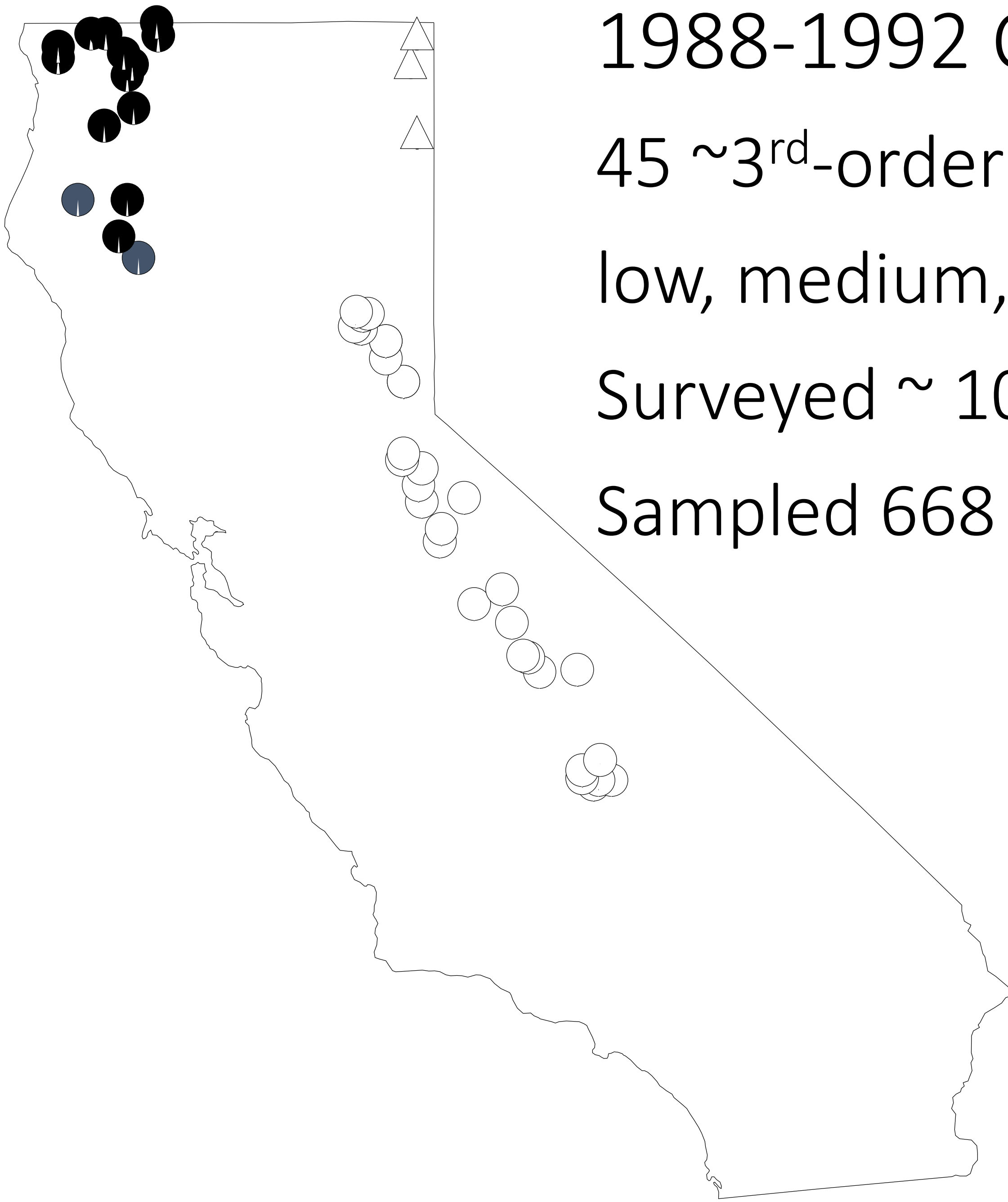
1993
Jim starts CA BAWG meetings



1983 – 1993
Serendipity reestablishes California connections and one project launches a bioassessment trajectory

- 1983-1985: Effects of a snail grazer on stream communities (with Joseph Furnish).
- 1985-1988: Recovery of stream ecosystems at Mount Saint Helens.
- **1988-1992: Response of stream biota to cumulative watershed effects associated with forest management with Lynn Decker (a UCD grad).**
- **1992-1993: Selecting priority sites for riparian wetland restoration: a case study in the San Luis Rey Watershed**

The cumulative watershed effects study



1988-1992 CWE Study

45 ~3rd-order catchments

low, medium, high impacts

Surveyed ~ 10 km of each stream

Sampled 668 riffles for BMIs




Evaluation Data Set

- 668 riffle samples from 45 mountainous basins in California.
- 9 Surber samples taken from each riffle.
- 261 reference-quality sites after dropping data from bedrock and boulder riffles.
- Reference sites defined as sites with < 5% of upstream basin logged.

The ‘birth’ of Bioassessment Chuck 1994 NABS (SFS) – Orlando, FL

- My CWE talk was put in a Bioassessment session.
- Used some ‘metrics’ in analyses because other standard analyses didn’t show much.
- Long and short of my talk:
  - No systematic bug or fish response to the management gradient.
  - MMI-type metrics were insensitive.
  - Natural gradients swamped signals.

Chuck stumbles into the Index Wars

<u>MMI Warrior 1</u>

Shut the door. No one leaves until we clarify what he said.

<u>MMI Warrior 2</u>

You've done bioassessment programs a grave disservice. The regulated community was just waiting for someone to say something like this.

<u>Richard Norris</u>

You had them by the balls!

<u>Roger Green</u>

…but you let them go! You could have stuck the dagger deeper!

But the problem was that I had no alternative to offer ….., just negative results!

Richard Norris offered to pay my way to Australia for a 3-month study leave.

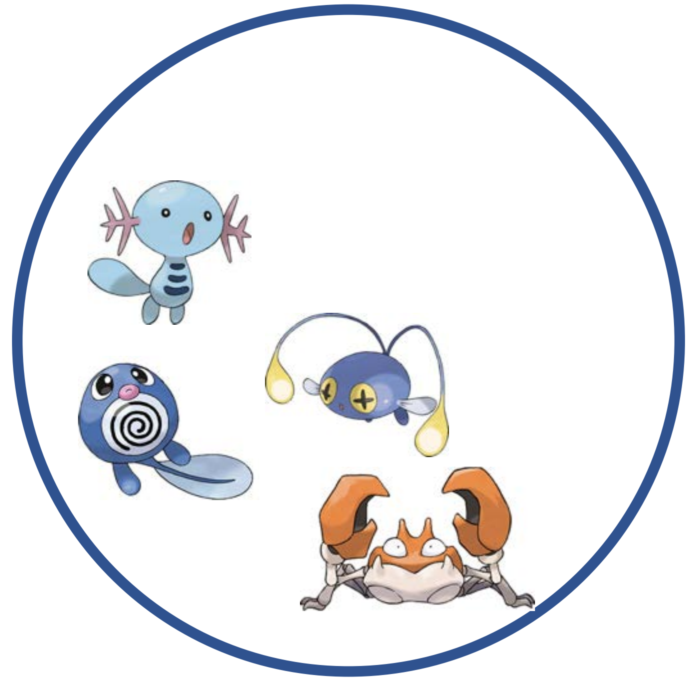
Trip 1: University of Washington (2 days)

Trip 2: University of Canberra (3 months)

RIVPACS models produce an intuitively simple index of taxonomic completeness (O/E)

Expected = 10

Observed = 4



O/E = 0.4

Applied CA data to RIVPACS while I was in Australia

Contrast	O/E	MMI*
Reference	0.99	2.36
Managed	0.84***	2.46
North Coast	0.90	2.55
Sierra Nevada	0.92	2.28***

* We scaled the MMI differently that is normally done, but scaling had no effect on inferences.

Percent of test sites judged impaired by different indices and reference value criteria

Measure	< 2 SD	<10th %	<25%
O/E	32	53	75
MMI	1	3	23

DEVELOPMENT AND EVALUATION OF PREDICTIVE MODELS FOR MEASURING THE BIOLOGICAL INTEGRITY OF STREAMS

Charles P. Hawkins,[1,3] Richard H. Norris,[2] James N. Hogue,[1,4] and Jack W. Feminella[1,5]

[1]*Department of Fisheries and Wildlife, Watershed Science Unit, and Ecology Center, Utah State University, Logan, Utah 84322-5210 USA*
[2]*Cooperative Research Centre for Freshwater Ecology, University of Canberra, ACT, 2616 Australia*

QUANTIFYING BIOLOGICAL INTEGRITY BY TAXONOMIC COMPLETENESS: ITS UTILITY IN REGIONAL AND GLOBAL ASSESSMENTS

Charles P. Hawkins[1]

Western Center for Monitoring and Assessment of Freshwater Ecosystems, Department of Aquatic, Watershed, & Earth Resources, Utah State University, Logan, Utah 84322-5210 USA

Multitaxon distribution models reveal severe alteration in the regional biodiversity of freshwater invertebrates

Charles P. Hawkins[1,3] and Lester L. Yuan[2,4]

[1]Department of Watershed Sciences, Western Center for Monitoring and Assessment of Freshwater Ecosystems, and Ecology Center, 5210 Old Main Hill, Utah State University, Logan, Utah 84322-5210 USA
[2]Office of Science and Technology, Office of Water, US Environmental Protection Agency, Mail Code 4304T, 1200 Pennsylvania Avenue NW, Washington, DC 20460 USA

The California CWE study bore more fruit!

J. N. Am. Benthol. Soc., 1997, 16(4):728–749

Channel morphology, water temperature, and assemblage structure of stream insects

CHARLES P. HAWKINS AND JAMES N. HOGUE[1]

Department of Fisheries and Wildlife / Ecology Center, Utah State University, Logan, Utah 84322-5210 USA

LYNN M. DECKER[2]

Pacific Southwest Region 5, USDA Forest Service, 630 Sansome Street, San Francisco, California 94111 USA

JACK W. FEMINELLA[3]

Department of Fisheries and Wildlife, Utah State University, Logan, Utah 84322-5210 USA

Range of temperatures and potential correlates across the 45 basins

Variable	Min	Max
Mean DT temperature (C)	8.6	20.6
Max DT temperature (C)	14.0	29.0
DT temperature range (C)	2.0	15.0
Elevation (m)	500	1568
Latitude (DD)	36	42
Channel slope (%)	2	11
Riffle velocity (cm/s)	17	104
% channel length as pool	9	69
Pool depth (cm)	18	63
Riffle width (m)	2.0	6.5
Riparian shading (%)	**17**	**90**

Riparian shade R^2

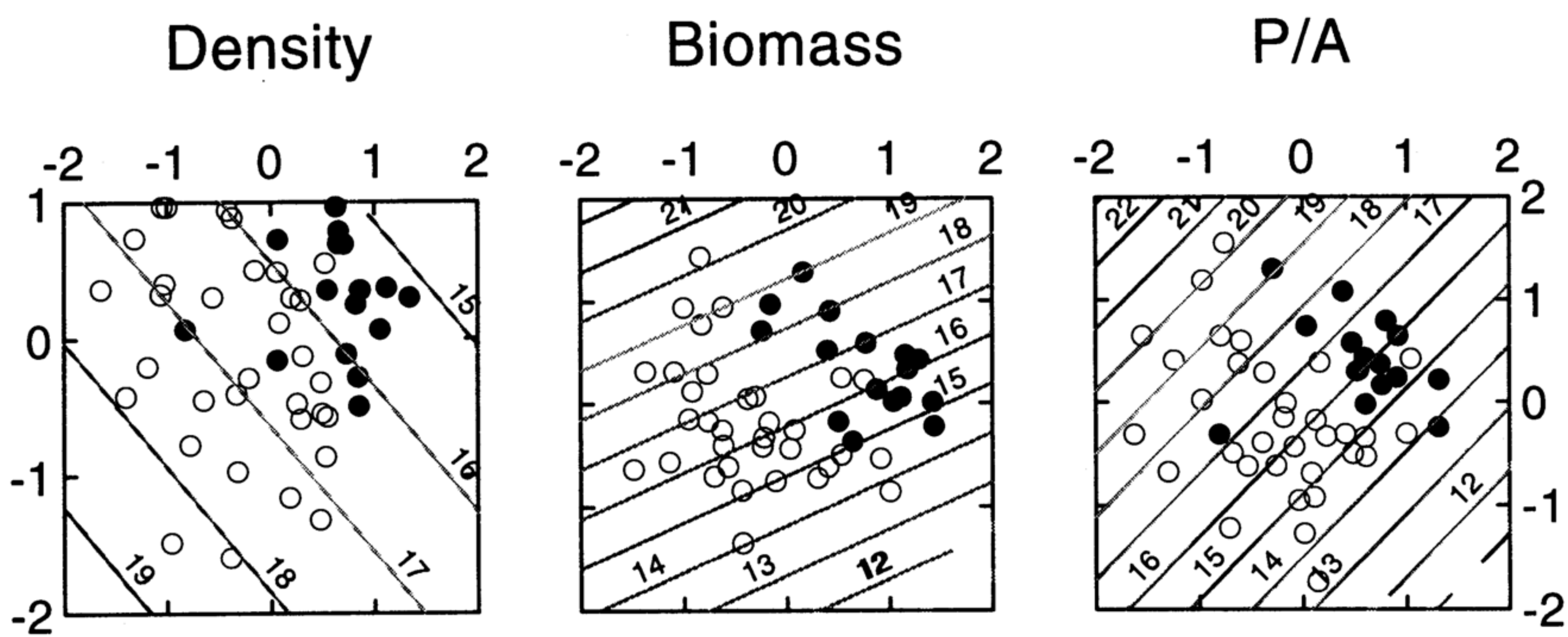
Mean DTT = 0

DT Range = 0.20

Regression model for mean daytime temperature (C). R^2 = 0.62		
Source of variation	STD Regression Coefficient	*P*
Constant	0.00	0.001
% channel as pools	**0.76**	0.001
Mean pool depth	**-0.45**	0.001
Mean riffle width	**0.24**	0.042

Variation in composition based on density was weakly associated with temperature.

Variation in composition based on biomass and presence/absence data was strongly associated with temperature!



We need to model naturally occurring environmental gradients if we want to accurately predict aquatic-life reference conditions!!!

Which would also allow us to develop waterbody-specific criteria for temperature, water chemistry, hydrology, substrate composition, and other physiochemical factors!

J. N. Am. Benthol. Soc., 2010, 29(1):312–343

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The reference condition: predicting benchmarks for ecological and water-quality assessments

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Charles P. Hawkins[1], John R. Olson[2], AND Ryan A. Hill[3]
Western Center for Monitoring and Assessment of Freshwater Ecosystems, Department of Watershed Sciences, Ecology Center, Utah State University, Logan, Utah 84322-5210 USA

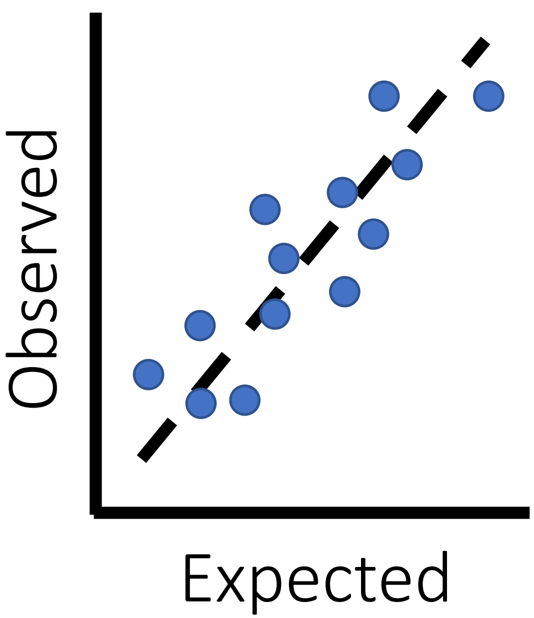
John Olson
Water Chemistry
Climate Change

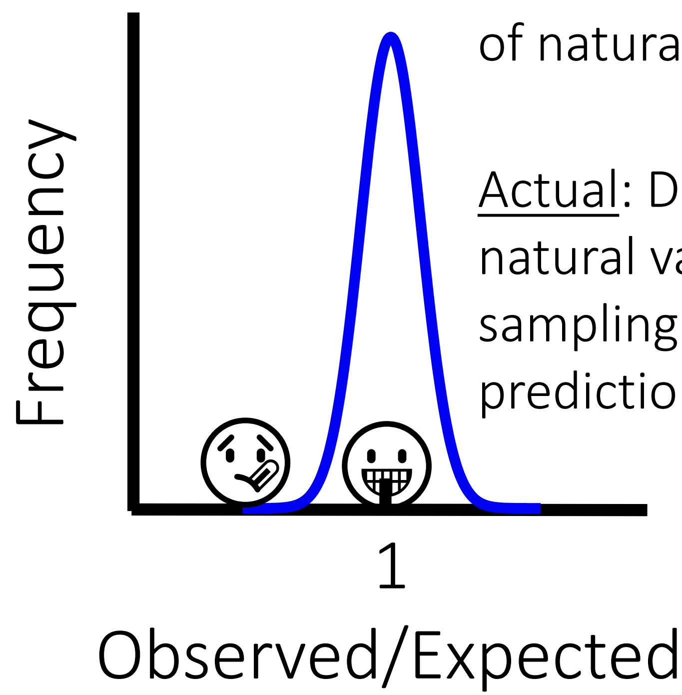
Sulochan Dhungal
Hydrology
Climate Change

Ryan Hill
Stream Temperature
Climate Change

Jake Vander Lann
Hydrology Regime
Lake Temperature
Climate Change

My 25-year obsession: Predictive accuracy and precision informs assessments

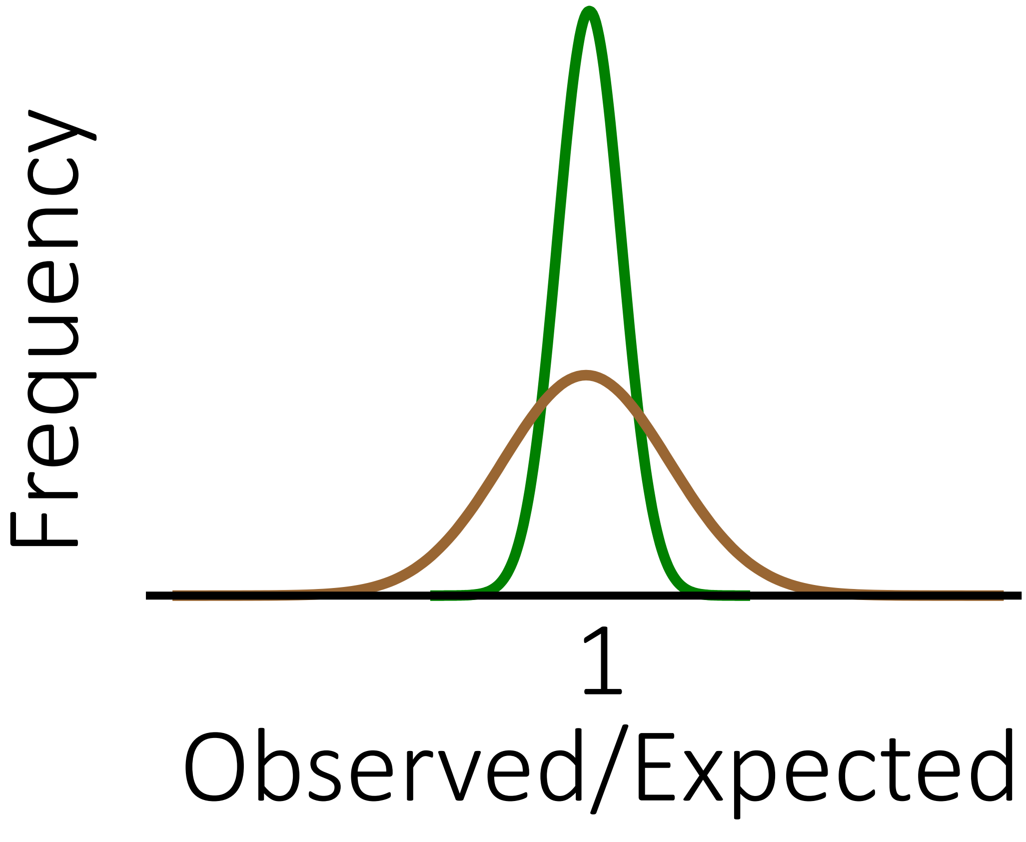




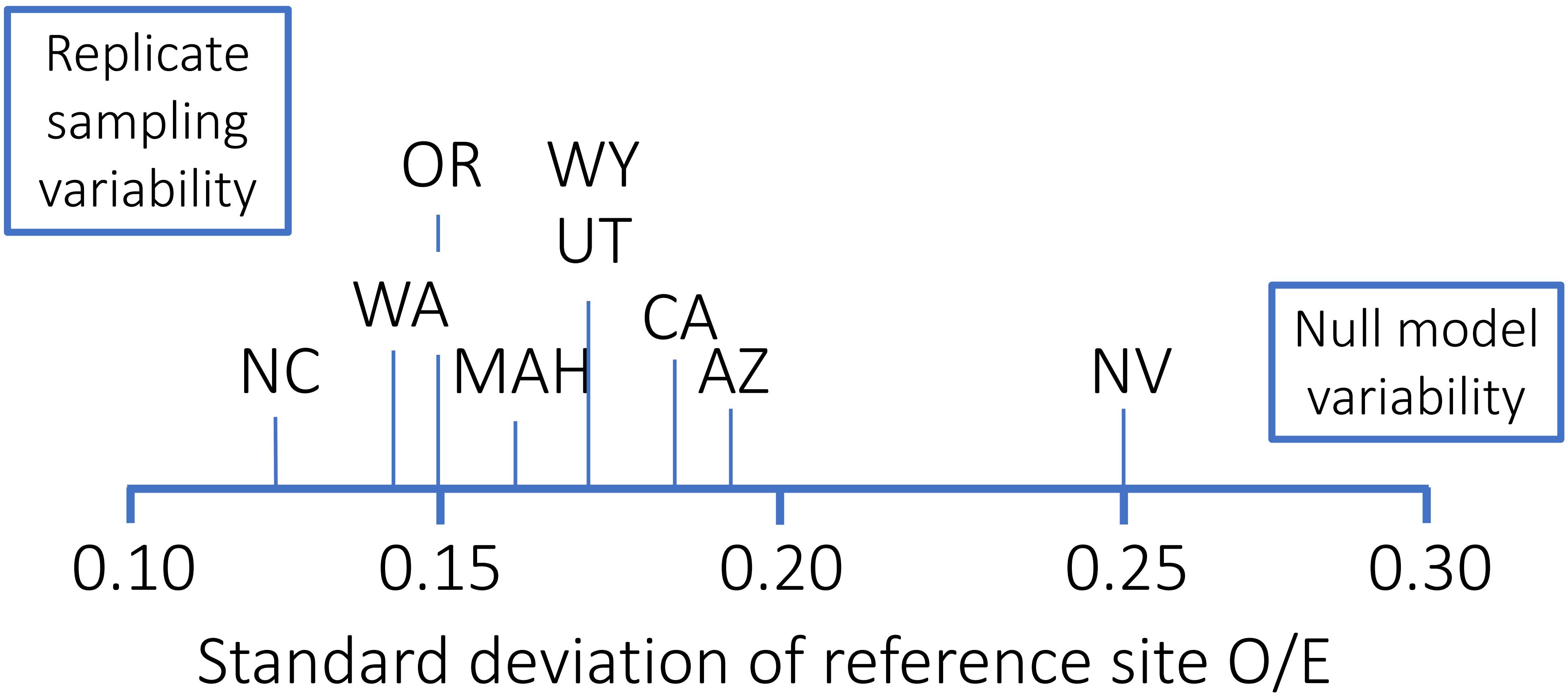
Ideal: Distribution of reference site scores estimates a site's range of natural variation

Actual: Distribution = natural variation + sampling error + prediction error

But not all predictions are equally precise!



Variation in precision of 9 O/E indices



Why the difference?

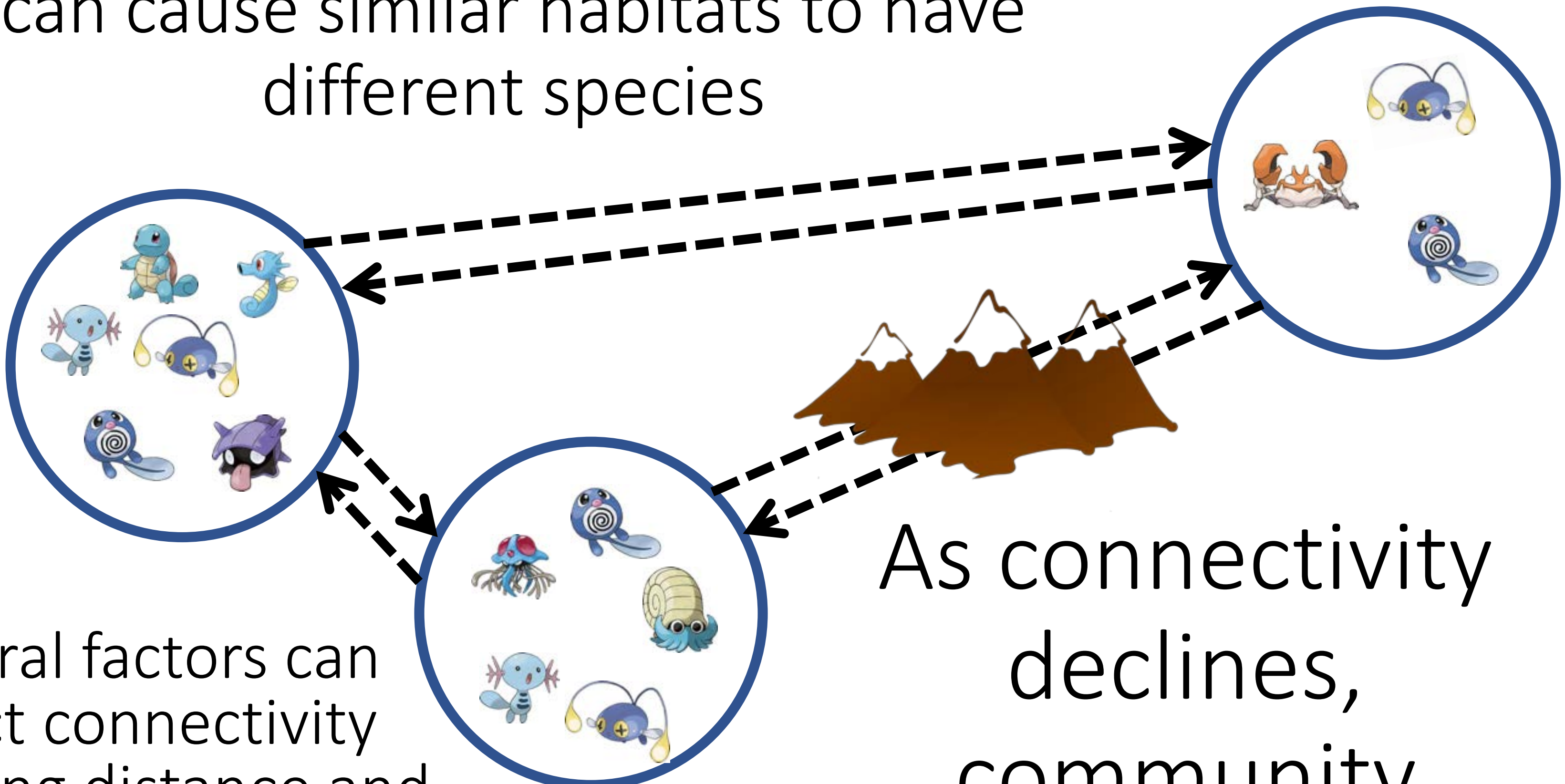
- Variable metacommunity dynamics?
- Variable sampling error?
- Variable reference site quality?
- Variable prediction error?

Larger sample counts
More flexible models
Better reference sites
Better predictors

→

Better predictions?

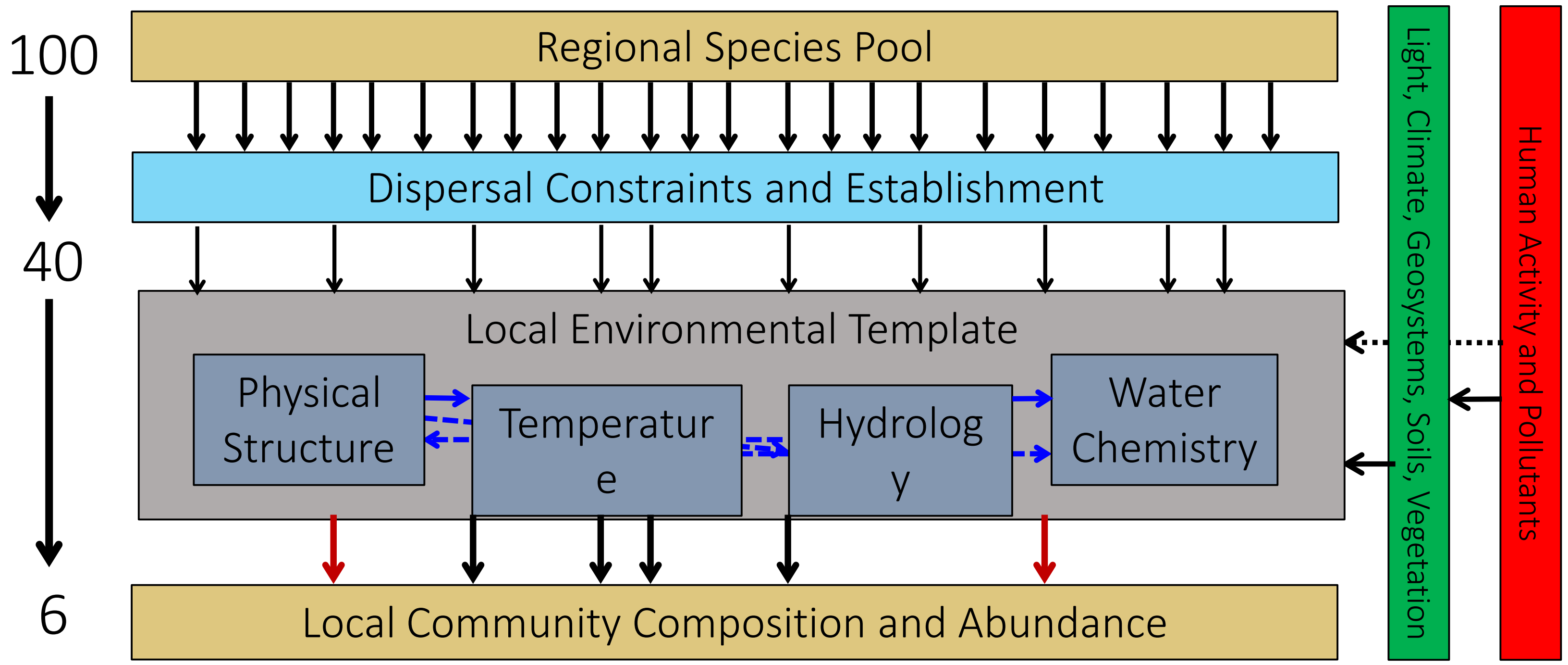
Maybe differences in connectivity can cause similar habitats to have different species



Several factors can affect connectivity including distance and barriers

As connectivity declines, community predictability will too

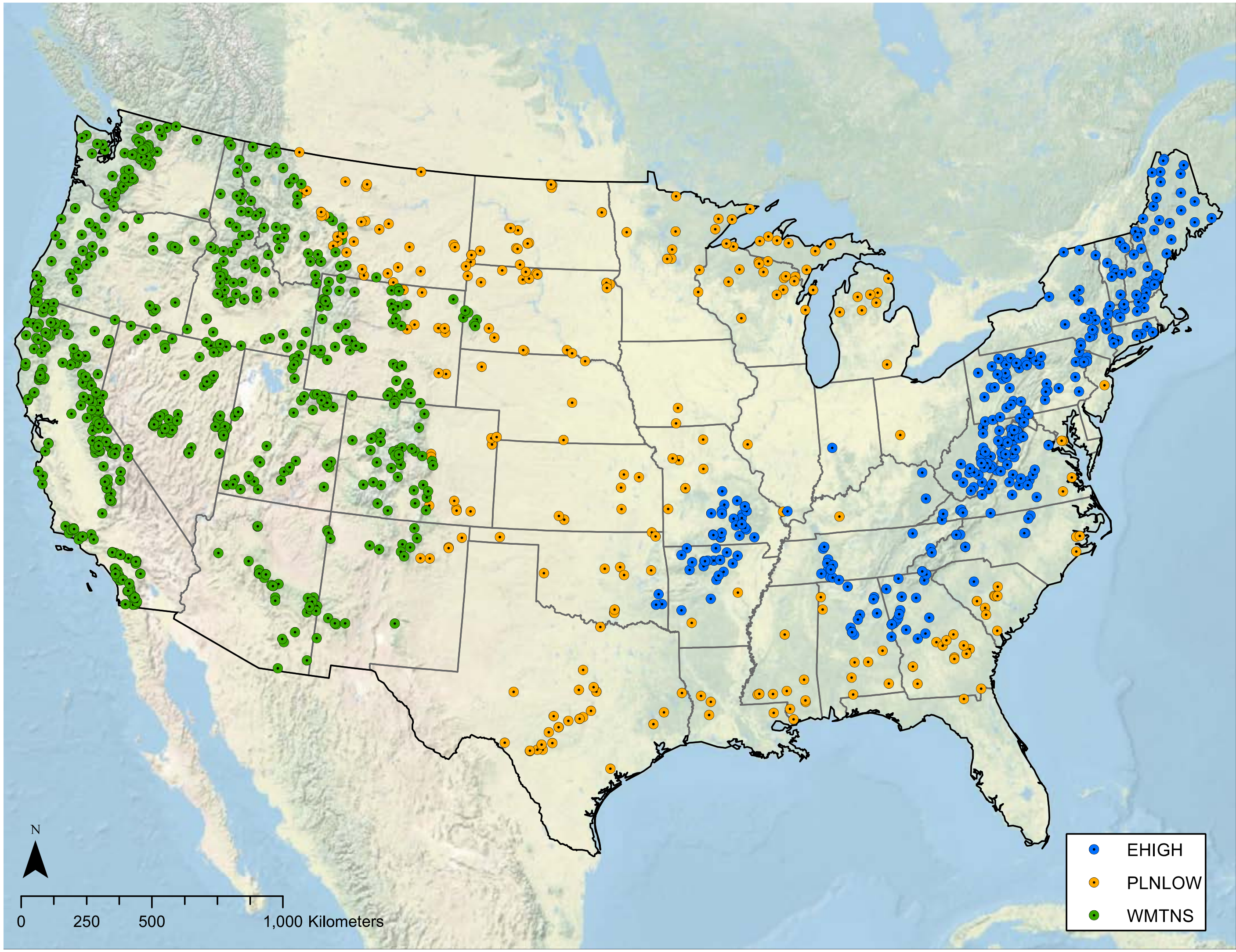
Metacommunity theory predicts that both niche and dispersal processes affect local community composition



The CONUS-wide data (NRSA)

1,313 reference sites

1280 invertebrate taxa

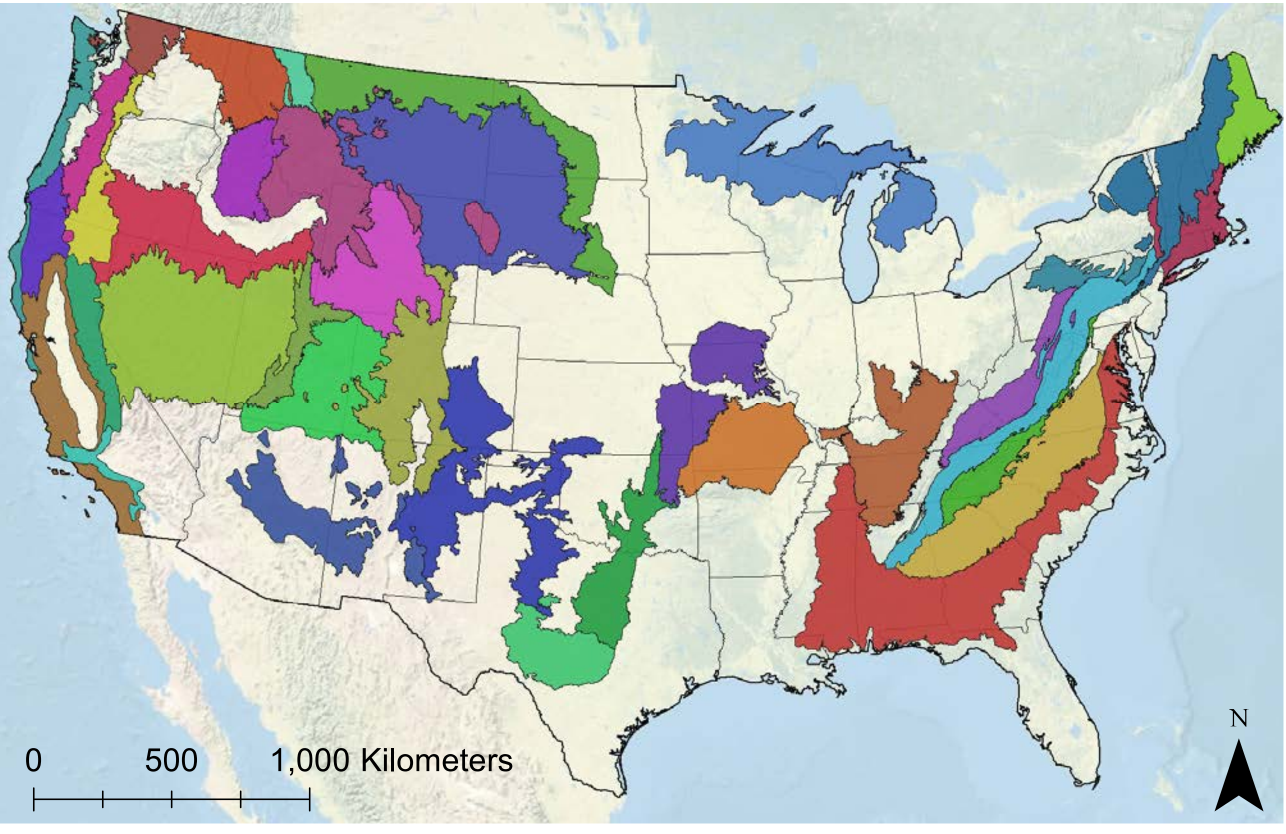


Does predictability vary across the CONUS?

37 ecoregions that varied in climate and topography.

Calculated ecoregion-specific O/E SDs.

Modeled O/E SD = f(regional drainage density, flow metrics, and productivity).

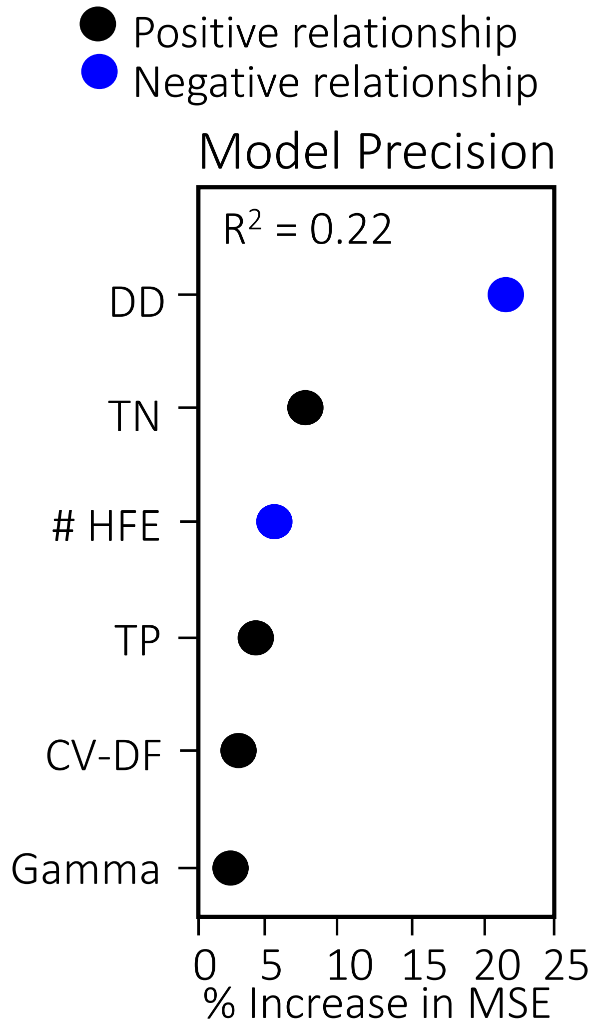


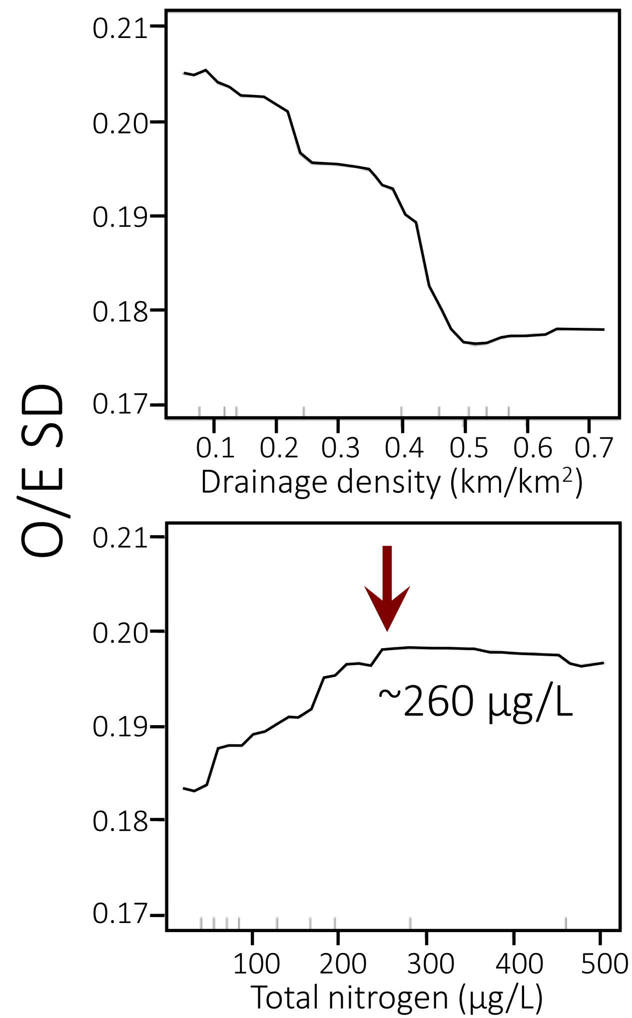
Two-fold variation across regions in model precision

Range of O/E SD

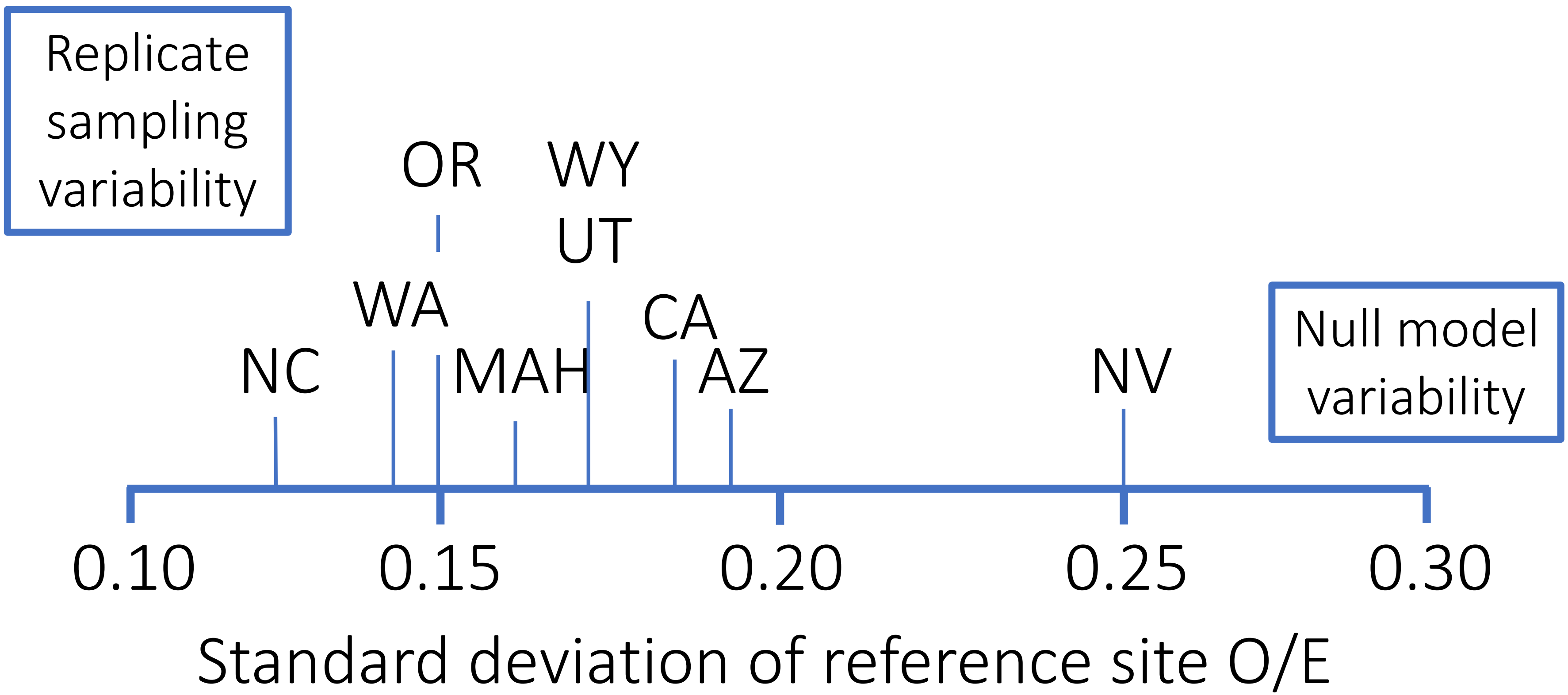
0.16 – 0.31

Regional model precision was most strongly associated with drainage density and productive capacity!





Variation in precision of 9 O/E indices



What will bring me back to BAWG in the future?

- California-based work:
  - Water Board / SWAMP committee work
  - Characterizing aquatic life with DNA (with Daren Carlisle).
  - Conservation planning for sensitive amphibians with data-based decision support systems (with John Olson).
- But other work might be of interest:
  - Global change.
  - Revisiting thermal ecology.
  - Better understanding local and regional causes and effects of salinization.
- But ultimately, BAWG is just a dam good meeting (and its close to ARBOGA!)